WIRELESS APPARATUS. By R. L. SMITH-ROSE, D.Sc., Ph.D., A.M.I.E.E.

The novel apparatus which falls within the radio-frequency range shown at this year's Exhibition is conveniently divisible into three classes, namely, apparatus for measurements at radio-frequencies, thermionic valves, and transmitting and receiving apparatus.

APPARATUS FOR MEASUREMENTS AT RADIO-FREQUENCIES

In the research and experimental section of the Exhibition Mr E. B. Moullin showed a new form of variable condenser, the capacity range of which covered a change of only 16 micro-microfarads, the first 47° of the scale corresponding to an increase of capacity of 1 micro-microfarad. This very small change is obtained by the unusual construction of the condenser, which consists of two circular cylinders whose axes are parallel but not concentric, the inner cylinder being rotated on an axle which is eccentric with both the outer and inner cylinder. Two mica condensers, each of 16 micro-microfarads capacity, are contained within the condenser and can be placed in parallel with the variable portion by a simple switch arrangement. The condenser is intended primarily for measurements at frequencies of the order of 30 million cycles per second. A novel feature of the instrument is that a switch is provided to connect the two cylinders, thereby transforming the instrument into a small variable inductance. This arrangement enables a measurement to be made of the residual inductance of the condenser which, it is to be noted, is engraved on the instrument.

On the stand of the National Physical Laboratory, Mr F. M. Colebrook showed an assembly of apparatus for the measurement of resistance and reactance at radio-frequencies, as illustrated in Fig. 1. The method employed depends upon the effect of the circuit under measurement when this is coupled loosely to a valve oscillator and is tuned through the working frequency. A demonstration was given which showed the application of the method to the measurements of resistance and reactance at frequencies up to 10 million cycles per second. On the same stand a demonstration of the type of apparatus employed at the National Physical Laboratory for the measurement of the overall performance of radio receivers was given by Mr H. A. Thomas. A supply of modulated radio-frequency current was obtained from suitable screened oscillators, and with the aid of some specially constructed screened resistances a known potential difference was applied to the input terminals of the receiver under test. For demonstration purposes the output audio-frequency current passing through the loud speaker was measured by means of a reflecting hot-wire galvanometer.

In the trade section of the Exhibition the stand of Messrs H. W. SULLIVAN, LTD., is always conspicuous for the large variety of precision-measuring apparatus for use at both radio- and audio-frequencies. Among the exhibits shown by this firm this year was a new quartz-controlled standard wavemeter by Mr H. J. Lucas. This consists of a specially cut crystal mounted *in vacuo*, the fundamental frequency of which is 50,000 cycles per second.

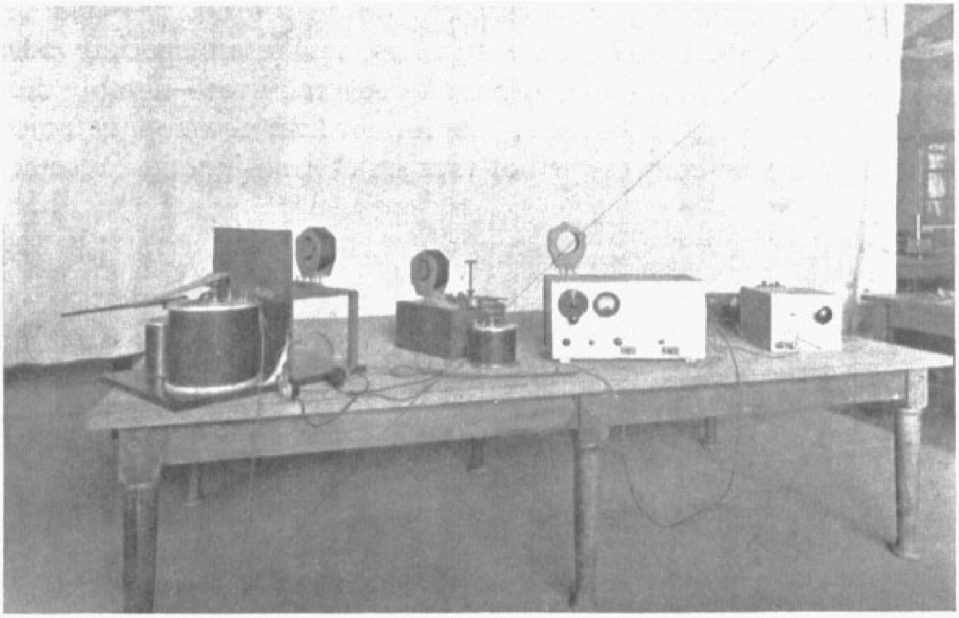

Fig. 1. Assembly of apparatus exhibited by the Wireless Division of the National Physical Laboratory for the measurement of resistance and reactance at radio-frequencies

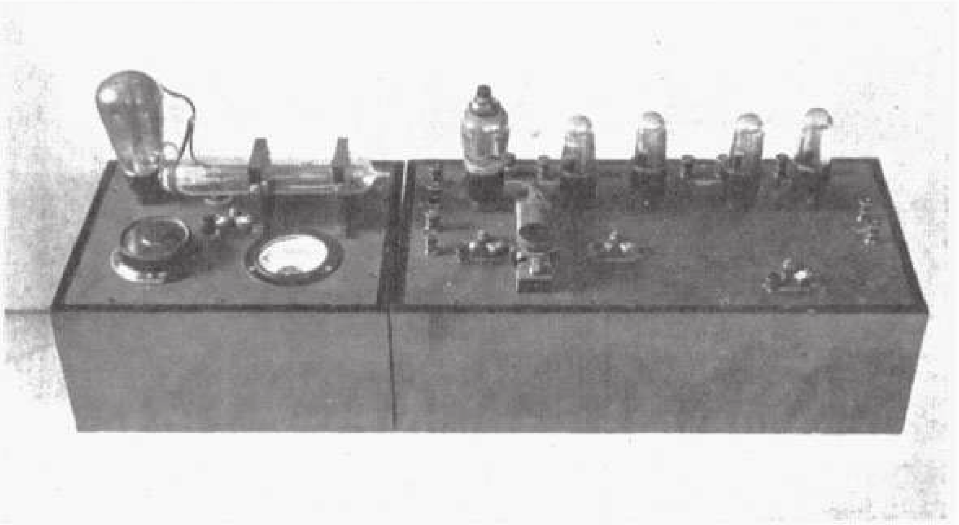

Fig. 2. Lucas-Sullivan quartz-controlled standard wavemeter, for a frequency range of from one to 6,000 kilocycles per second

The output from an oscillator valve controlled by this crystal is employed to control the 50th harmonic of a low-frequency oscillating circuit, the natural frequency of which is 1,000 cycles per second. At the same time the quartz-controlled oscillator is employed to control the frequency of another oscillating circuit ranging up to 6 million cycles per second. In this manner a range of controlled frequencies is available of from 1,000 to 6 million cycles per second in steps of 1,000 cycles per second. A photograph of this assembled apparatus is shown in Fig. 2. Another prominent feature of Messrs Sullivan's stand was a precision sub-standard wavemeter with a wave-length range of from 100 to 10,000 metres (Fig. 3). This instrument employs the standard variable air condenser shown by Mr W. H. F. Griffiths last year, and is used in conjunction with a series of fixed value inductances constructed in such a form as to ensure geometrical stability and freedom from temperature coefficient. A short wave precision sub-standard wavemeter for the shorter wave-length range of from 5 to 100 metres (see Fig. on p. 62), and several types of heterodyne wavemeter were also exhibited.

A large variety of voltmeters and ammeters, whose ranges are specially adapted for use in radio-frequency measurements, was exhibited by several firms – notably those of Messrs ELLIOTT BROS., LTD., and ERNEST TURNER. The former firm now supply a radio-frequency ammeter embodying the non-contact type of vacuum thermo-junction, a somewhat similar instrument being also supplied by the CAMBRIDGE INSTRUMENT CO., LTD. For making continuous records of the output signals from wireless receiving sets a convenient instrument is the "C.G.S." microamperegraph which was exhibited by O. E. MALINVERNO.

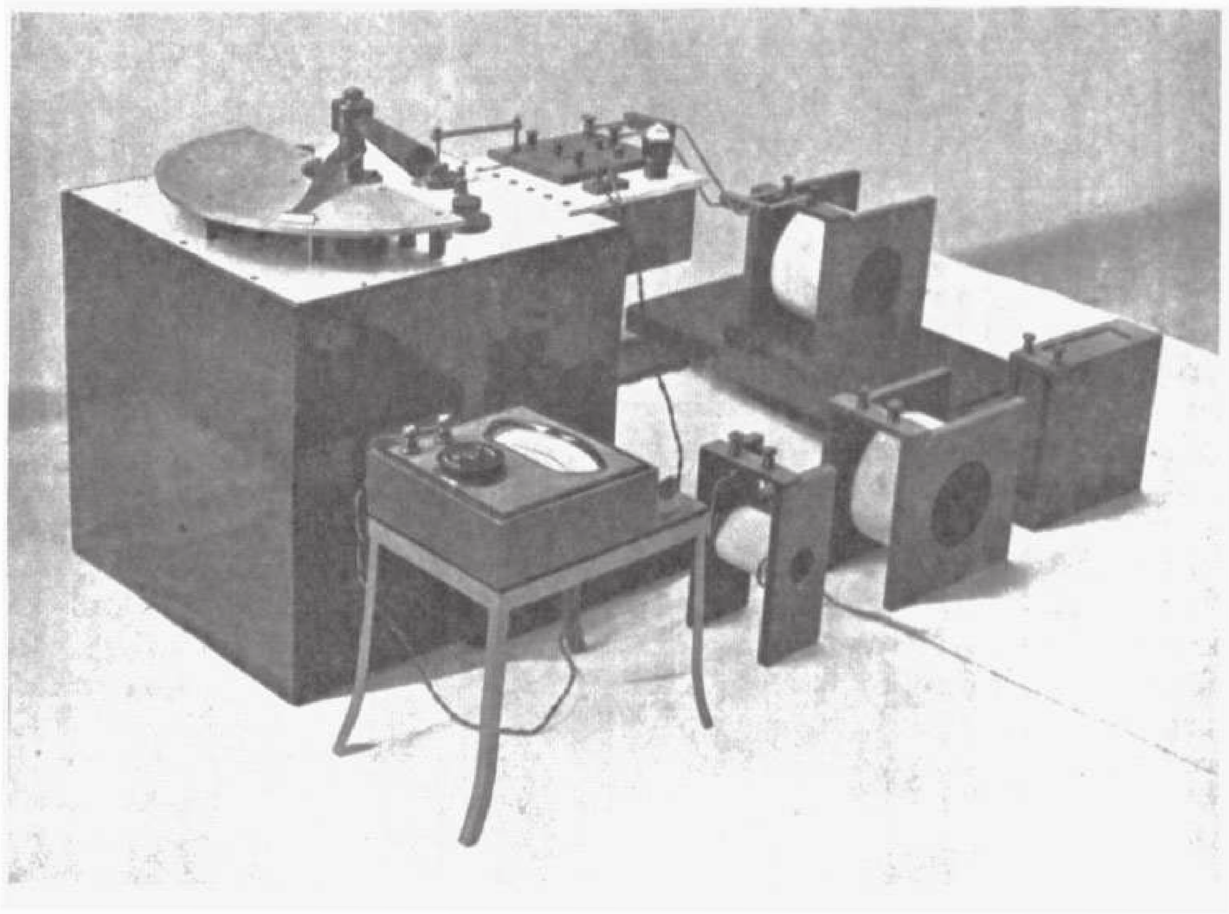

Fig. 3. The Sullivan-Griffiths sub-standard precision wavemeter for wave-lengths of from 100 to 10,000 metres

THERMIONIC VALVES

A large display of thermionic valves of the various types used both for transmission and reception was shown on the stands of the M. O. VALVE CO., LTD., the MULLARD WIRELESS SERVICE CO., LTD., and the EDISON SWAN ELECTRIC CO., LTD. The first-named firm exhibited several types of water-cooled high power transmitting valves and samples of the most recent types of receiving valves with both directly and indirectly heated cathodes. An automatic grid making machine, as employed at the OSRAM VALVE WORKS, was also shown in operation. An interesting novelty among the moderate power transmitting valves was the Ediswan short wave type which consisted of two complete electrode systems mounted in one glass envelope. This assembly was in effect two 250-watt valves conveniently arranged for connecting to a short wave transmitting circuit of the familiar "push-pull" type. The **British Thomson-Houston Co., Ltd.**, showed amongst its experimental exhibits a method of measuring the total emission of a valve by means of a mechanical switch which applies the voltage for 1/100th second. The electron current given by this application of voltage is measured by a ballistic galvanometer, thus rendering it possible to measure the total emission without overheating or otherwise damaging the filaments.

TRANSMITTING AND RECEIVING APPARATUS

The present tendency of radio research in the direction of higher frequencies was well illustrated by two exhibits in the Research and Experimental Section of the Exhibition. Prof. L. S. Palmer and Mr L. L. K. Honeyball demonstrated a short wave directional wireless transmitter working on a wave-length in the neighbourhood of 8 metres. The inductance of the oscillatory circuit was formed of a single turn of copper tubing of about 1 inch in diameter. Two low-power transmitting valves were connected in parallel on one side of the loop while a tuning condenser was incorporated on the opposite side. The filament supply leads to the valves were taken round one side of the loop inside the copper tube, thus avoiding induction by stray fields from the oscillating circuit into the filament circuit. This transmitter was operated from a power supply unit which is self-contained and designed to run from a D.C. supply of 60 volts. Other types of experimental transmitting and receiving apparatus, for wave-lengths below 10 metres, were shown by Dr R. L. Smith-Rose and Mr J. S. McPetrie on the stand of the **National Physical Laboratory**. One of these comprised a two-valve oscillator using short path receiving valves and oscillating at a frequency of 200 million cycles per second (wave-length 1·5 metres). On a larger scale a transmitter employing two 500-watt valves, with a wave-length range of from 5–10 metres, was also exhibited. For the carrying out of reception tests and measurements on such short wave-lengths a portable receiver was exhibited, a photograph of which is reproduced as Fig. 4. This receiver employs a single turn loop

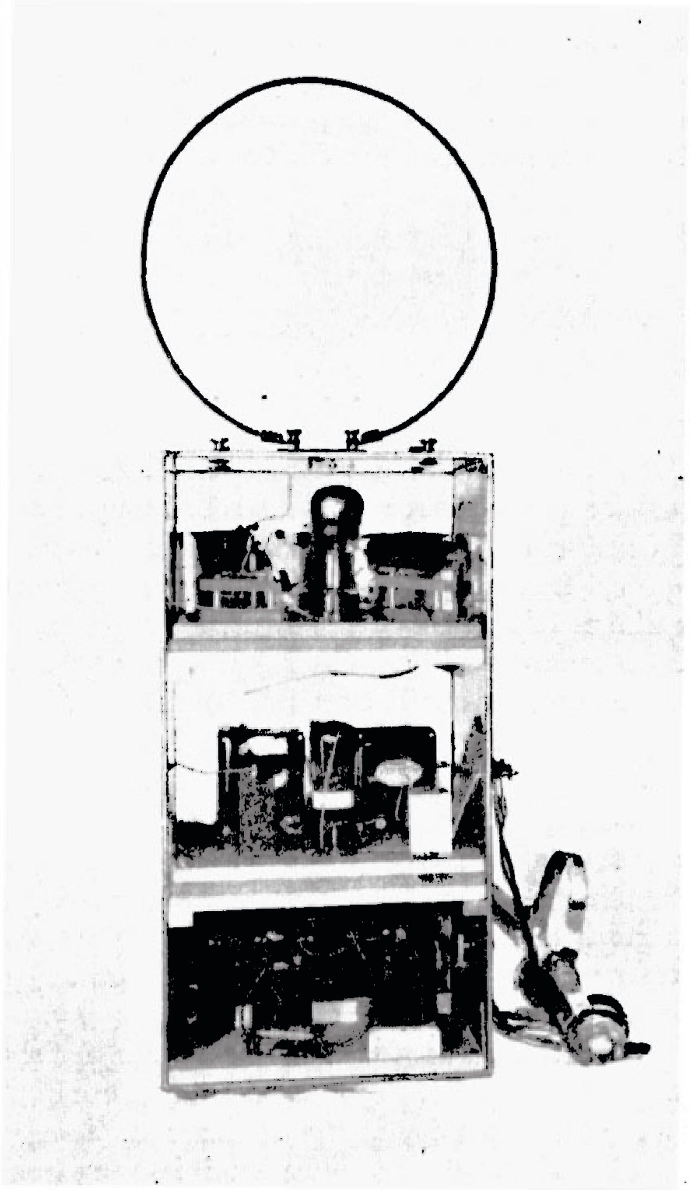

Fig. 4. A portable wireless receiver and direction-finder for wave-lengths of 4 to 10 metres shown by the Wireless Division of the National Physical Laboratory

which forms the main inductance of an oscillating detector valve. This stage is coupled to a single audio-frequency amplifying stage, and both of these with the necessary batteries are entirely enclosed in a screened box. The provision of an open wire screen around the receiving loop enables the receiver to be used as a direction-finder.

On the commercial side a number of receivers developed for special purposes were exhibited by MARCONI'S WIRELESS TELEGRAPH CO., LTD. Among these was a recent pattern of direction-finder as designed and fitted on various classes of naval ships as a navigation instrument. The equipment utilises two closed loops at right angles on the Bellini-Tosi system, these loops being shielded for mechanical and electrical purposes in metal tubes. An aircraft direction-finder of somewhat similar design, but with the frame aerial constructed in stream line fashion, was also exhibited.

In connexion with the application of directional wireless to marine navigation, an automatic recorder of wireless bearings from a rotating beacon transmitter has been developed at the NATIONAL PHYSICAL LABORATORY and was exhibited by Dr Smith-Rose and Mr H. A. Thomas. The recorder has been specially developed for the taking of bearings on a ship from a rotating loop beacon of the type now in operation at Orfordness, and sample records as obtained with the instrument were exhibited. In this connexion mention may also be made of the special type of stop-watch provided with a compass card dial, shown on the stand of Messrs HENRY HUGHES & SON, LTD., for use in conjunction with the Orfordness beacon.